



1 February 2024

Towards net-zero emission of T&D grids



The global perspective

by Philippe ADAM, CIGRE Secretary General



Content

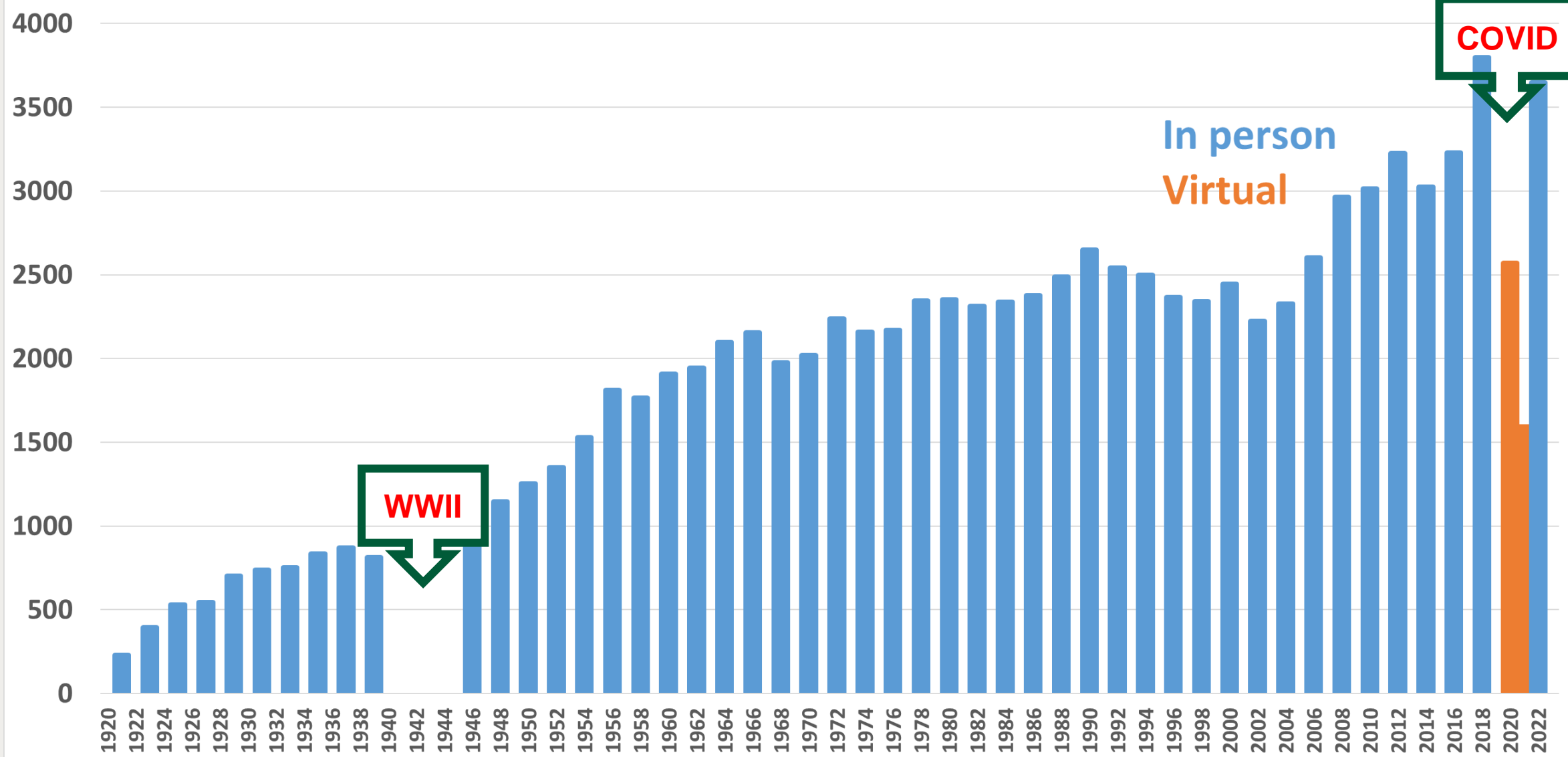
1. CIGRE brief history
2. CIGRE today
3. CIGRE vision of the energy transition
 - The legacy power system
 - The power system of the future
 - The technical challenges of the transition
4. CIGRE contribution to the transition



A brief history of CIGRE from 1921 to now

- 1921 : a **conference**, Conférence Internationale des Grands Réseaux Electriques = CIGRE, (International **Conference** on Large Electric Systems), created to **prepare for standardisation** in the sector stimulated by the post-war economy,
- 1931 : established by French Law as **non for profit** association
- 2000 : Legal name = International **Council** on Large Electric Systems
- 2018 : branding campaign : CIGRE the **brand name** no longer an acronym
- CIGRE dedicated to “**Power System Expertise**” promoting exchanges and facilitating the collaboration on topical issues,
 - ✓ Electrification of territories (1920 - 1950)
 - ✓ Transmission and interconnection (1950 - 1990)
 - ✓ Electricity markets (1990 - 2010)
 - ✓ Energy transition (2010 - 2030)

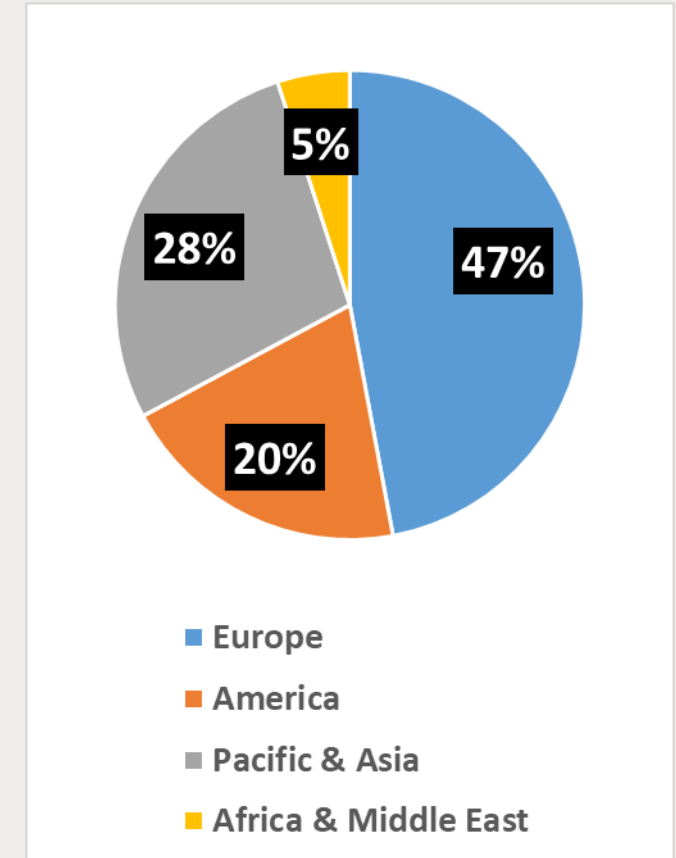
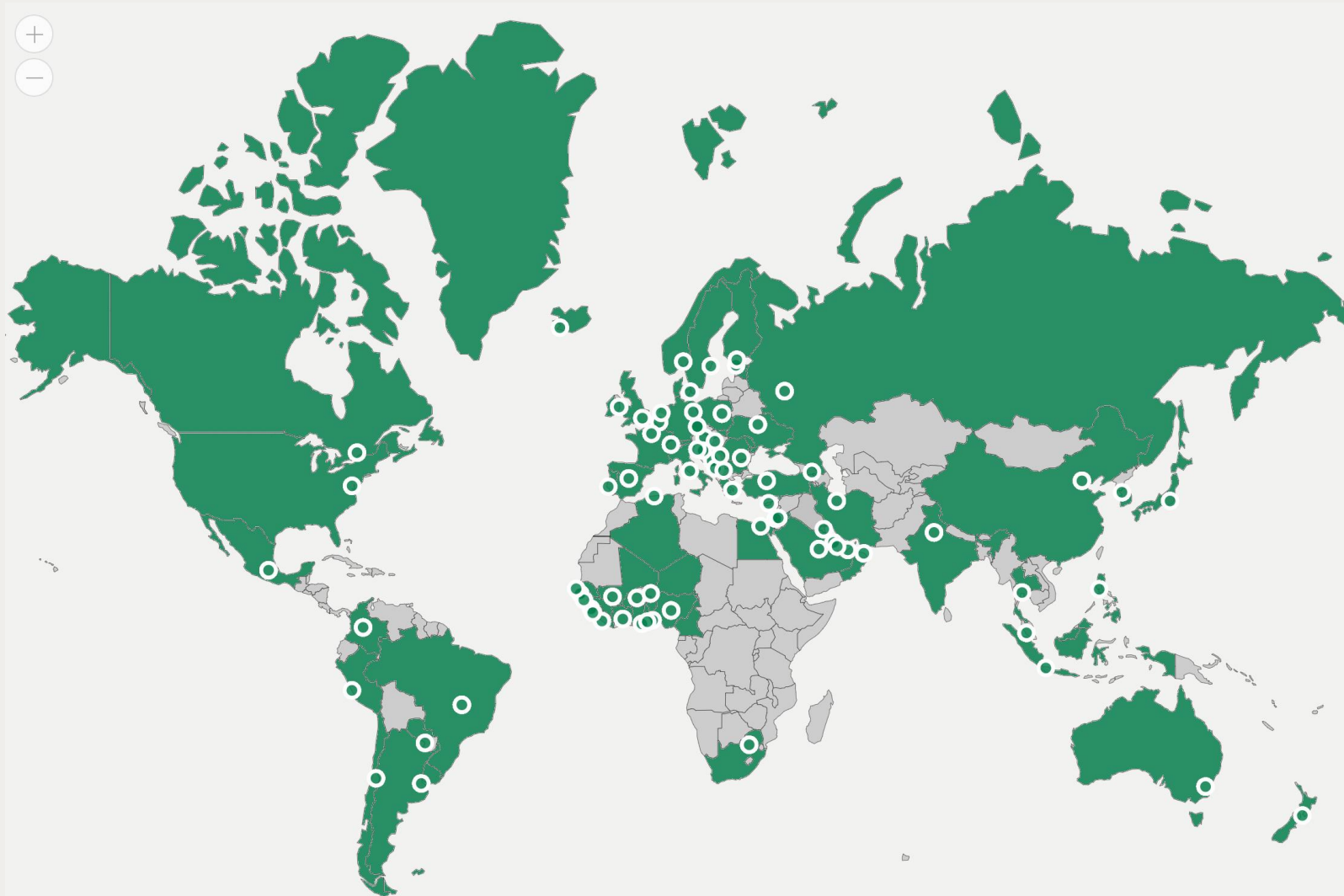
CIGRE Paris Session attendance



CIGRE Session, Palais des Congrès de Paris, August 28, 2022

A wide-angle photograph of a large audience seated in a conference hall. The audience is diverse in age and appearance, mostly men in business attire. They are seated in rows of red chairs, facing towards the left side of the frame where a stage area is visible. The stage is illuminated with bright blue light, and a large screen is visible in the background. The ceiling is dark with many small lights. The overall atmosphere is professional and formal.

The CIGRE community in 2024 = 61 National Committees



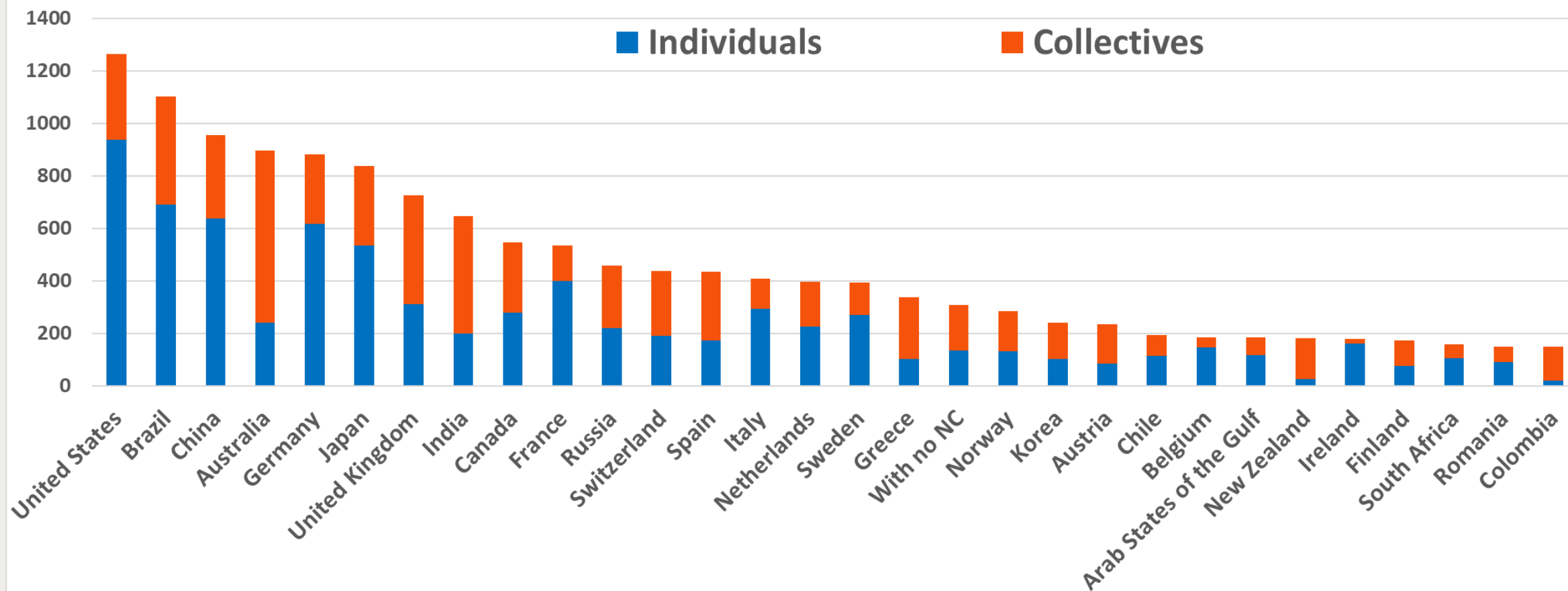
CIGRE members' profiles

- Operators:
 - Transmission Systems (TSO)
 - Distribution Systems (DSO)
 - Power generators
 - Utilities
 - Independant Systems (ISO)
 - T&D asset owners
 - Power markets
- Technology providers:
 - Transmission equipement
 - Distribution equipment
 - Information & communication
- Consulting companies
- Testing laboratories
- Research centres
- Universities
- Regulators
- Professional associations

11,000 individual members
30% young professional (<35)
12.6% women
1,400 collective members

CIGRE equivalent membership in 2023

2023 National Committees ranking by equivalent membership (1st half)



CIGRE's 16 domains of work = 16 Study Committees



More than 260 active Working Groups

Edition and publication

ELECTRA
CIGRE's Digital magazine



 **ELECTRA** ©2023 - CIGRE

**CIGRE SCIENCE
& ENGINEERING**



 **CIGRE SCIENCE
& ENGINEERING** ©2023 - CIGRE

B3 Substation and elec
A3 Transmission distribut



Guidelines for S
treatment of T&
in substations

 **TECHNICAL BR**
August 2023 - Refe

CIGRE Green Books
Compact Studies

CIGRE Study Committee B

Peter Bishop
Nirmal-Kumar C. Nair Ed

IEC 6185
Principles
Application
to Electr
Systems

 **cigre**



before 30 June each year

In the case of CIGRE, the
must also approve the ne
the Paris Session.

In Session years, the Ger
for the next two years.

This year, the Ordinary G
rate of 6.7%, the lowest r

Nevertheless, all four res
Administrative Council we
from 91.2% to 98.2%.



Dear Reader, Dear Colleagues,

This issue of the Future Connection
addressed contributions from Study
Installations, and D2 on Information
special topic, we will introduce to yc
seven new Study Committee (SC) C

 **Sp**



The latest from the world of C
innovations, new tech and the
technical challenges of the po



July 2022



Editorial
By Michel Augonnet, President of CIGRE

Dear Colleagues:

As the year 2022 moves forward, we are getting closer to the
CIGRE in-person Session in Paris. I sincerely hope that we will
have the pleasure to meet during the various exchanges that will be taking place.

This year's Session contributions have been incredible in number and quality ,and
enhanced by two years of distancing.

This edition of leadership Circle includes considerations about the risks and challenges
associated with a high pace of deploying a carbon neutral grid:

- An article By Dr. Shay Bahramirad, Senior Vice President of Engineering and Asset Management at LUMA Energy (Power Company in Puerto Rico) & President-Elect of IEEE Power and Energy Society
- Topic: The urgency of rebuilding the grid that could outpace the readiness of the transition, and inadvertently exacerbate inequalities and reduce resilience during an overzealous transition period.

Events organised by CIGRE

In total, several hundreds of CIGRE events per year

- **Paris Session** in even years, the reference congress for all members organized by the Central Office (CO) (3,700 delegates from 95 countries in 2022)
- **Symposia**, two per odd years outside of Paris, organised by one National Committee (NC), the Technical Council (TC) and the CO
- **Colloquia** organised by a Study Committee in association with a NC
- **Regional conferences** organised by groups of NCs
- **National Conferences** organised by NCs
- **Webinars** organised by the Study Committees with the CO or by the NCs

CIGRE Strategic Plan - 2023 to 2030 horizon - Why?

- The energy transition will have disruptive, challenging, and exciting changes.
- CIGRE sees the power industry on an expansive track, in terms of its scope and range of activities.
- CIGRE is a leading platform for knowledge sharing, a true on-line laboratory to assist innovators in the development of suitable products for a sustainable future of our planet.
- CIGRE is well positioned to meet these challenges with its fundamental neutrality for knowledge sharing.
- CIGRE proposes this 2023 revision for its Strategic Plan with a horizon of 2030 to ensure its leadership for power system expertise for its stakeholders, and for societal needs for electricity.

CIGRE Strategic Plan - Core Goals Continued...

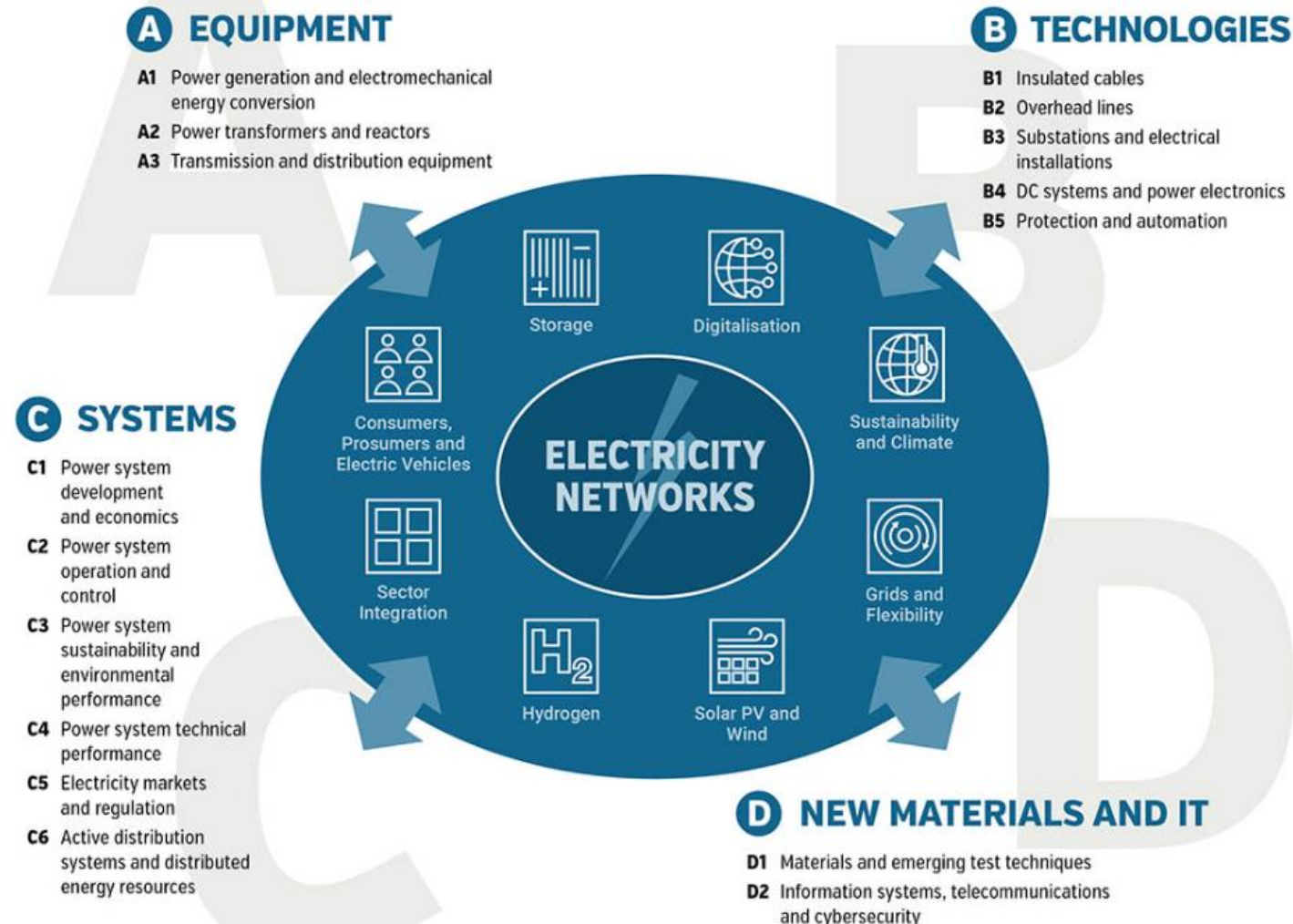
- Facilitating and developing the exchange of engineering and electricity market knowledge and information on power systems.
- Adding value to knowledge and information exchanges by synthesizing state-of-the-art and global best practices.
- Contributing to the promotion of social sustainable development.
- Developing guidelines and information to aid the emergence of new technologies and techniques.
- Fostering growth and development opportunities for the future workforce needed for the energy transition.
- Growing membership and member services to fulfill our Purpose, Vision, Mission, and Values.

CIGRE to meet the future of the Energy Transition

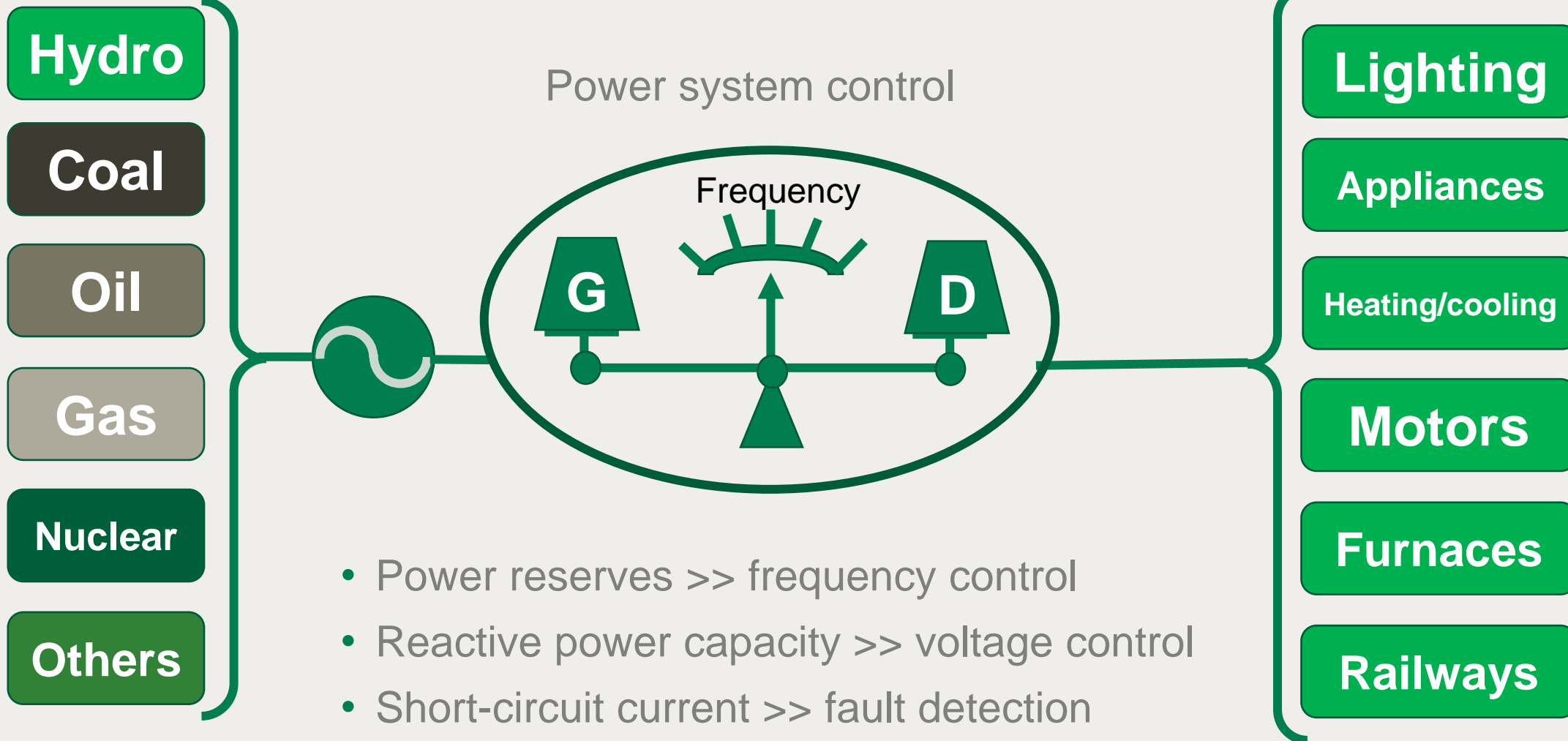
Provide greater visibility
to the following topics:

	Digitalisation VIEW		Solar PV and Wind VIEW
	Storage VIEW		Hydrogen VIEW
	Grids and Flexibility VIEW		Consumers, Prosumers and Electric Vehicles VIEW
	Sustainability and Climate VIEW		Sector Integration VIEW

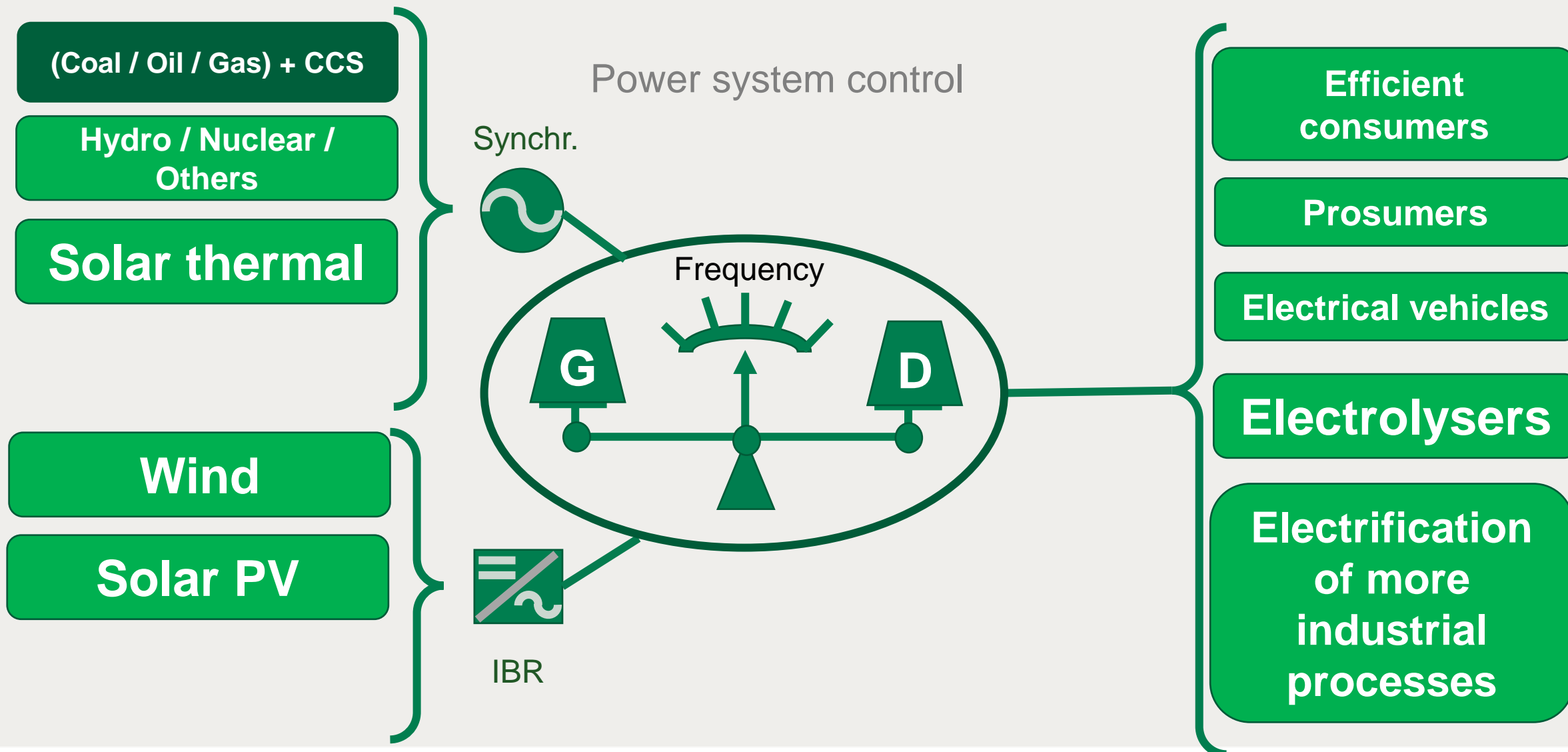
CIGRE and the Energy Transition



The legacy power system

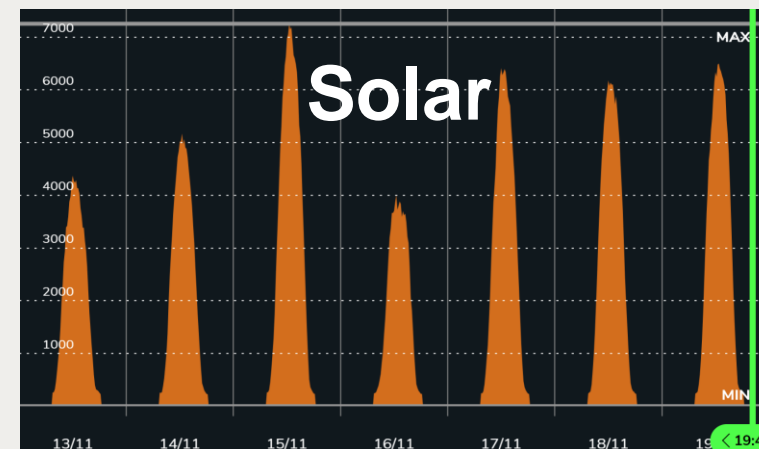
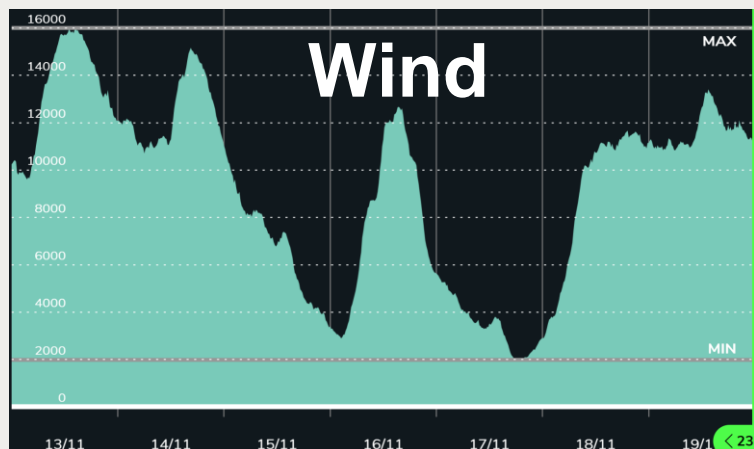


The power system of the future



The technical challenges of the transition

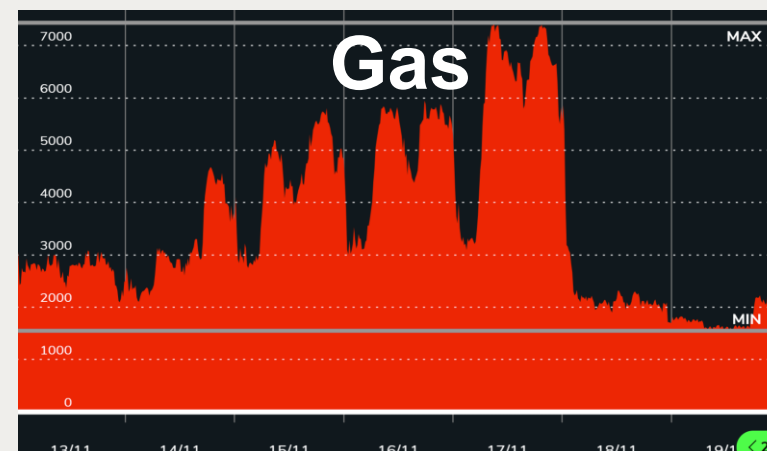
- Solar and wind generation are intermittent and not controllable



Generation in
France in the
week November
13 to 19, 2023

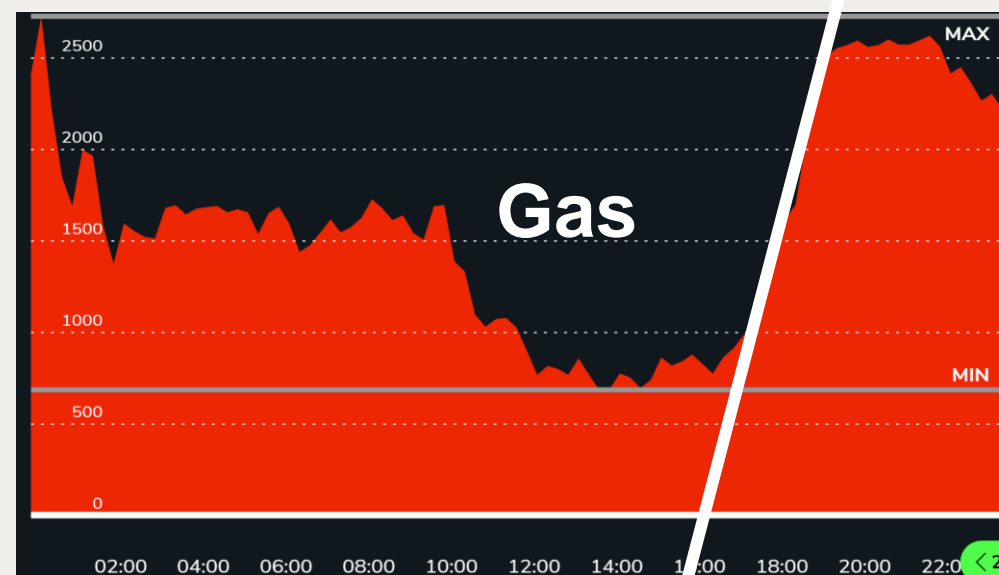
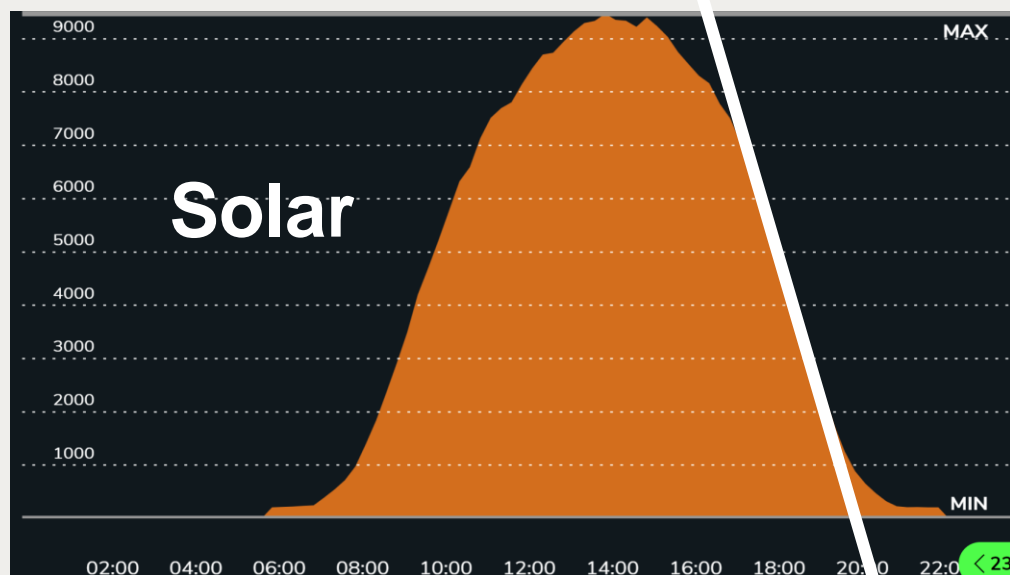
Source: RTE

- Mitigation with:
 - Backup generation
 - Storage systems
 - Flexibility of consumers
 - Interconnection



The technical challenges of the transition

- Fast power generation changes of wind and solar



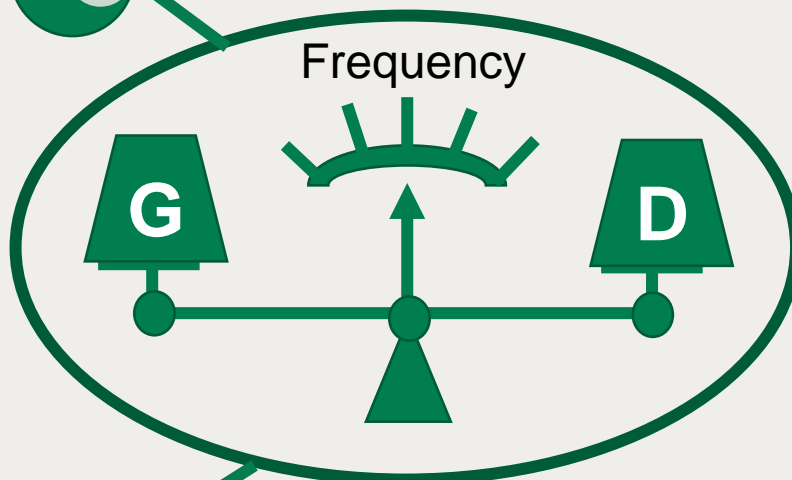
- Mitigation with fast backup generation: gas turbines, storage

Generation in
France on
August 15, 2023
Source: RTE

The power system of the future

Power system control

Synchr.



IBR

(Coal / Oil / Gas) + CCS

Hydro / Nuclear /
Others

Solar thermal

AC storage
discharge

Wind

Solar PV

DC storage
discharge

Efficient and
flexible consumers

Prosumers

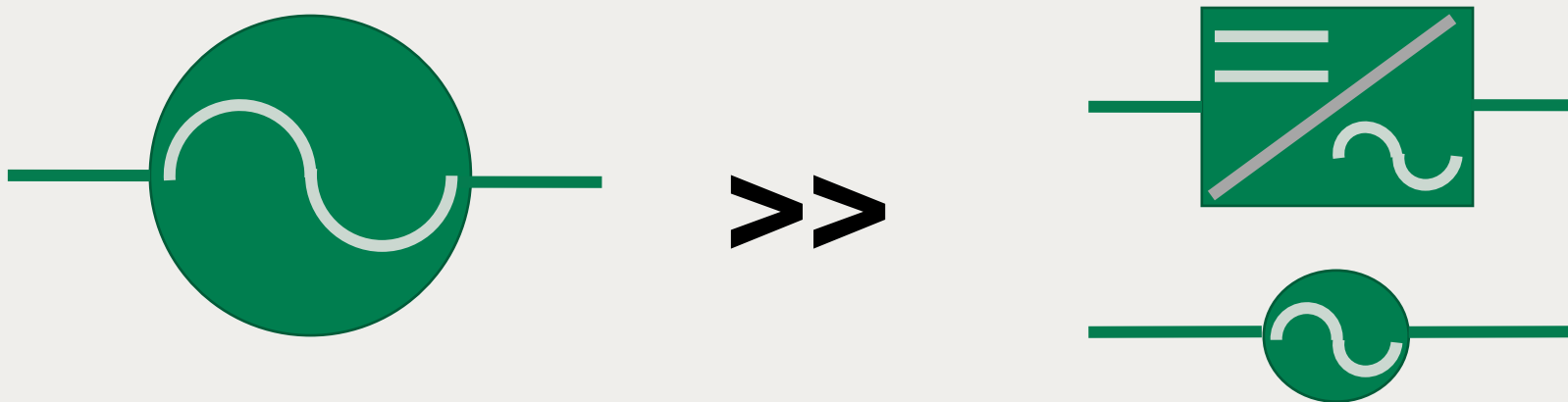
AC & DC storage
charging + EVs

Electrolysers

**Electrification
of more
industrial
processes**

The technical challenges of the transition

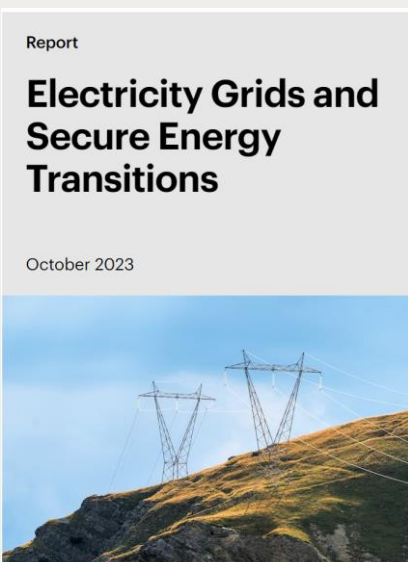
- Large amount of inverter based resources
 - Reduction of system inertia >> frequency control issues
 - Reduction of short-circuit current >> fault detection and protection operation



- Mitigation:
 - Synchronous compensators with inertia
 - Grid forming inverters with storage
- Modelling of the fast response of power electronics

The technical challenges of the transition

- Geographic dispersion of wind and solar:
 - Voltage control in distribution networks
 - Harvesting over wide areas on-shore and off-shore
 - Transmission over long distances from on-shore and off-shore generation to consumption areas
 - More infrastructures for distribution and transmission



International Energy Agency report:

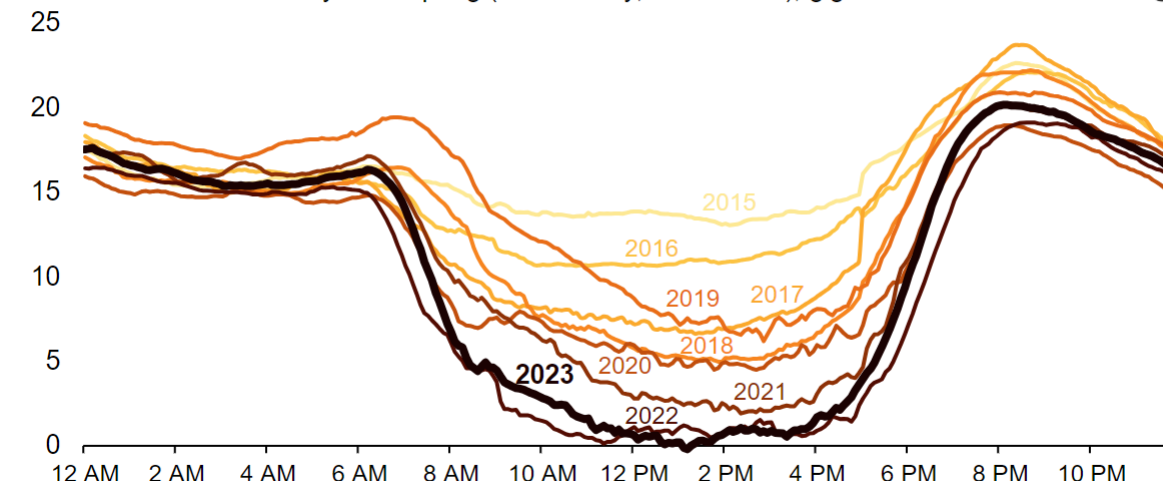
- Modern, smart and expanded grids are essential for successful energy transitions
- Grids risk becoming the weak link of clean energy transitions
- Action today can secure grids for the future

The technical challenges of the transition

- Power market issues:
 - Overgeneration « duck curve »
 - Negative kWh prices
- Exchanges of data and communication
 - Operation of more complex systems
 - DSO/TSO interactions
 - Guaranty of origins (blockchain)
 - Cybersecurity

California's duck curve is getting deeper

CAISO lowest net load day each spring (March–May, 2015–2023), gigawatts



Data source: [California Independent System Operator \(CAISO\)](#)

CIGRE contribution to the transition

- Based on the experiences of its members, CIGRE is addressing the challenges described above, and appointed Working Groups to propose state of the art, best practices and recommendations on system planning, design, construction and operation in the new context of the energy transition
- By selecting relevant topics for its conferences (Paris Session, symposia), CIGRE facilitates the sharing of operational experiences
- The « Large disturbance workshop » of the Paris Session is an opportunity for experts to share lessons learnt from large incidents or blackouts due to the integration of large amounts of renewable energy sources
- CIGRE stimulates technical innovations by bringing together experts from the operators, research centers, consultants, and technology providers, to solve problems at a global level

<https://www.cigre.org>

<https://e-cigre.org>

<https://join.cigre.org>

<https://session.cigre.org>



1 February 2024

Towards net-zero emission of T&D grids

